ACTIVE LIST OF PERMISSIBLE EXPLOSIVES AND BLASTING DEVICES APPROVED BEFORE DECEMBER 31, 1957

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ACTIVE LIST OF PERMISSIBLE EXPLOSIVES AND BLASTING DEVICES APPROVED BEFORE DECEMBER 31, 1957[1]

by

N. E. Hanna[2] and G. H. Damon[3]

INTRODUCTION

To be approved for use in underground coal mines in the United States, explosives and blasting devices must pass certain safety tests prescribed by the Federal Bureau of Mines. These tests are described in Schedule 1-G[4] (explosives) and Schedule 26A[5] (blasting devices).

An explosive or blasting device that passes the appropriate tests is placed on the active permissible list. As this list is subject to continuous revision, it has been the practice of the Bureau of Mines to publish periodically the names of explosives and blasting devices that have been added to the active list, as well as those that have been transferred to the inactive list; changes in brand names also are reported.

The present circular gives all explosives and blasting devices on the active permissible list as of December 31, 1957, and shows all changes, additions, and transfers in that list between December 31, 1951,[6] and December 31, 1957.

PERMISSIBLE EXPLOSIVES TESTED UNDER SCHEDULE 1-G

The term "permissible explosive" as applied by the Bureau of Mines means (1) that the explosive conforms, within tolerance limits prescribed by the Bureau of Mines, with the basic sample that passed all the scheduled tests and (2) that, when the explosive is applied for blasting coal, it is used in the manner prescribed.[7] For an explosive to continue to be listed as permissible, it must conform, as above with the basic sample, and the diameters of the cartridges used must be those that

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[4] Bureau of Mines, U. S. Department of the Interior, Schedule 1-G, Explosives: Federal Register, Mar. 24, 1955, vol. 20, No. 58.

[5] Bureau of Mines, U. S. Department of the Interior, Schedule 26A, Blasting Devices: Federal Register, Mar. 22, 1955, vol. 20, No. 56.

[6] Hanna, N. E., and Damon, G. H., Active List of Permissible Explosives and Blasting Devices Approved Before December 31, 1951: Bureau of Mines Inf. Circ. 7640, 1952, 12 pp.

[7] For detailed specifications, see appendix I.

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have been approved. For an explosive to retain its permissible character after being marketed, it must at all times be handled, transported, and stored to retain its original characteristics. Explosives should be purchased in fresh condition and in such quantities as to allow prompt utilization.

Types of Explosives

When permissibles are listed, a distinction is made between gelatinous and nongelatinous explosives. Nongelatinous explosives (table 1) are well adapted for use in mines that are relatively dry. As these explosives can deteriorate by absorbed moisture, creating a tendency toward propagation failures, exposure to very damp atmospheres should be as brief as possible.

Gelatinous explosives (table 2) are designed especially for blasting rock in coal mines, although, under certain conditions, they have proved suitable for blasting coal. They are better adapted for use in wet mines. Their rates of detonation range from 2,200 to 5,600 meters per second. As they are very dense, they provide more energy for a given volume of borehole charge.

Classification on Basis of Toxic Gases Liberated

All permissible explosives emit some toxic gases upon detonation, together with a much larger volume of nontoxic gases. To prevent toxic gases from becoming a health hazard under normal conditions, no explosive can be listed as permissible if it generates more than 106 liters of toxic gases per 1-1/2 pounds (2-1/2 cu. ft. per pound) upon detonation, as determined by tests in the Bichel pressure gage.

Classification on the basis of the volume of toxic gases liberated by 680 grams (1-1/2 pounds) of explosive is as follows: Class A, not more than 53 liters; class B, between 53 and 106 liters.

Current Active List of Permissible Explosives

The previous active list of permissible explosives, published in August 1952, included 174 brands. Modifications in the list authorized to December 31, 1957; as a result of tests on new explosives, transfers from the inactive list, and changes in brand names; have added 33 brand names to the current active permissible list, as follows:

Austin Red Diamond No. 5	Transferred from inactive list.
Coalite 7-R	Do.
Coalite LL	New explosive.
Coalite LL-1	Do.
Independent C-1	Do.
King No. 5-A	Transferred from inactive list.
King No. 8	Do.
King No. 9	Do.
King No. 9-A	Same as Black Diamond No. 9-A.
King No. 11	Transferred from inactive list.
King No. 11-A	Do.
King No. 11-B	Same as Black Diamond No. 11-B.
King No. 12-B	Same as Black Diamond No. 12-B.
King No. 55	Same as Black Diamond No. 55.
King G	Transferred from inactive list.
King Special A	Do.

King Special C	Transferred from inactive list.
King Nu-Gel No. 4	Do.
Peerless No. 2	Do.
Super-X No. 2	Formerly Liberty No. 2 and Columbia 3.
Super-X No. 2-A	Formerly Liberty No. 2-A and Columbia D.
Super-X No. 3	Formerly Liberty No. 3 and Columbia C.
Super-X No. 3-A	Formerly Liberty No. 3-A and Columbia C-1.
Super-X No. 5	Formerly Liberty No. 5 and Columbia 4.
Super-X No. 7	Formerly Liberty No. 7, Columbia B, and Alton No. 7.
Super-X No. 8	Formerly Liberty No. 8, Columbia E, and Alton No. 8.
Super-X No. 9	Formerly Liberty No. 9, Columbia G, and Alton No. 9.
Super-X No. 11	Formerly Liberty No. 11.
Super-X Gel	Formerly Liberty-Gel LF, Alton-Gel B, and Columbia-Gel 1.
Super-X Gel A	Formerly Liberty-Gel A and Columbia-Gel 3.
Super-X Gel B	Formerly Liberty-Gel B, Alton-Gel C, and Columbia-Gel 2.
Super-X Big Coal D	Formerly Columbia A and Big Coal D.
Super-X Big Red No. 7-C	Formerly Columbia B-2 and Big Red No. 7-C.

During the same period, 48 brand names were removed from the active list; 13 of these brands, listed below, were transferred to the inactive list; the remaining 35 brand names were dropped because of the adoption of new names.

American 1
Coalite E
Coalite L
Coalite L-1
Coalite O
Coalite 5-P
Coalite 6-P
Columbia F
Gelobel B
U. S. No. 15
U. S. A
U. S. G
U. S. Special C

Explosives formerly shown as being manufactured by the Illinois Powder Manufacturing Co. were transferred to the American Cyanamid Co. as a result of a merger of these companies.

The current list of permissible explosives includes 159 different brands; 19 of these are gelatinous, and the rest are the more commonly used granular ammonium nitrate type. This wide variety of permissibles offers an extensive choice of physical characteristics to meet the diversified needs of the coal-mining industry. Their rates of detonation range from 1,200 to 5,600 meters per second. About 30 percent of the rates are below 2,000 meters per second, 56 percent are between 2,000 and 3,000 meters per second, and the remainder are over 3,000 meters per second. The rates of detonation reported in earlier lists were measured in 28-gage sheet-metal tubes. These rates are now obtained using paper tubes, as is the practice in the explosives industry. As a result of this change in confinement, the rates published in the present list do not correspond with earlier published values. For nongelatinous explosives, the paper-tube rates average about 83 percent of the steel-tube rates. The detonation rates of all gelatin permissibles were redetermined in paper tubes, using a 60-gram tetryl booster for initiation. Because of the higher magnitude of initiation, the rates obtained for most explosives of the gelatinous class run somewhat higher than the results previously published.

The density of permissible explosives varies considerably; the weight of a 1-1/4- by 8-inch cartridge ranges from 86 to 244 grams and has a stick count of 264 to 93 per 50-pound box. Most permissibles are available in cartridge sizes from 1 to 2-1/2 inches in diameter; some are available in diameters as large as 3 inches. A No. 6 electric detonator was used in all tests conducted on the explosives now on the active permissible list, except the detonation rate tests on gelatinous explosives where a 60-gram tetryl booster was used. No detonator of less efficiency is authorized for firing permissible explosives in coal mines.

The complete active list of permissible explosives is given in tables 1 and 2.

PERMISSIBLE BLASTING DEVICES TESTED UNDER SCHEDULE 26A

The active list of permissible blasting devices, published in August 1952, included nine Cardox models. Changes in the list authorized to December 31, 1957, have added two models of the Hydrox blasting device to the active permissible list. Both devices utilize high-pressure discharges from a pressurized shell in the shothole. The high-pressure gases produced are released at high velocity by the shearing of a disk at the discharge head.

The Cardox blasting device utilizes liquid carbon dioxide as the blasting agent, which is gasified by the heat produced from an electrically ignited heating element consisting of a deflagrating mixture (potassium perchlorate and coal) immersed in the liquid carbon dioxide. This device must be charged and serviced at the surface.

Hydrox utilizes a gas-generating charge that is essentially a special ammonium nitrate composition converted to gaseous products by a pressurized chemical reaction. The charge is initiated by an electrically ignited chemical heater embedded in a starter mixture. The charging and servicing of this device is permitted underground.

The complete active list of Cardox and Hydrox blasting devices is given in tables 3 and 4, respectively. Requirements that must be satisfied in the use of blasting devices are listed in appendix II.

TABLE 1. - Nongelatinous permissible explosives

Brand	Toxic gas classification	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Paper-tube rate in 1-1/4-inch diameter cartridge				Manufacturer[1]
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
American 2	A	143	159	1	5,900	900	1,800	300	American
American 3-A	B	125	182	1	5,600	800	1,700	300	Do.
American 4-A	B	109	208	1	5,900	900	1,800	300	Do.
American 5	B	107	212	1	5,600	800	1,700	300	Do.
American 11	A	159	143	1	6,900	1,000	2,100	300	Do.
American 12	B	143	159	1	6,900	1,000	2,100	300	Do.
American 12-A	A	134	169	1	6,200	900	1,900	300	Do.
American 14-A	B	110	206	1	6,200	900	1,900	300	Do.
American 21	A	163	139	1	9,200	1,400	2,800	400	Do.
American 22	A	143	159	1	8,900	1,300	2,700	400	Do.
American 23	B	124	183	1	7,500	1,100	2,300	300	Do.
American A[2]	A	185	123	1	7,200	1,100	2,200	300	Do.
Apache Coal Powder A	B	137	166	1-1/4	9,800	1,500	3,000	500	Apache
Apache Coal Powder B	B	158	144	1-1/4	6,900	1,000	2,100	300	Do.
Apache Coal Powder H, L. F.	A	164	138	1-1/8	9,200	1,400	2,800	400	Do.
Austin Red Diamond No. 1	B	173	131	1	8,500	1,300	2,600	400	Austin
Austin Red Diamond No. 2	A	134	169	1-1/4	5,900	900	1,800	300	Do.
Austin Red Diamond No. 3	A	160	142	1-1/8	5,600	800	1,700	300	Do.
Austin Red Diamond No. 4	A	191	119	1	8,200	1,200	2,500	400	Do.
Austin Red Diamond No. 5[3,4]	A	161	141	1	6,600	1,000	2,000	300	Do.
Austin Red Diamond No. 9-B	B	133	171	1	6,200	900	1,900	300	Do.
Austin Red Diamond No. 9-C	B	144	158	1	7,200	1,100	2,200	300	Do.
Austin Red Diamond No. 10-A	B	123	185	1	6,900	1,000	2,100	300	Do.
Austin Red Diamond No. 11	B	101	225	1	5,900	900	1,800	300	Do.
Bituminite D	A	138	164	1-1/4	4,900	700	1,500	200	Hercules
Black Diamond No. 5-A	A	163	139	1	7,900	1,200	2,400	400	American
Black Diamond No. 7	A	183	124	1	8,900	1,300	2,700	400	Do.
Black Diamond No. 7-A	B	155	146	1	9,500	1,400	2,900	400	Do.
Black Diamond No. 7-AA	A	156	146	1	9,200	1,400	2,800	400	Do.
Black Diamond No. 8	A	134	169	1	6,200	900	1,900	300	Do.
Black Diamond No. 9	B	144	158	1	7,200	1,100	2,200	300	Do.
Black Diamond No. 9-A	A	147	154	1	6,600	1,000	2,000	300	Do.
Black Diamond No. 11	B	123	185	1	7,200	1,100	2,200	300	Do.
Black Diamond No. 11-A	B	111	205	1	8,500	1,300	2,600	400	Do.
Black Diamond No. 11-B	A	115	197	1	5,900	900	1,800	300	Do.
Black Diamond No. 12-B	B	105	216	1-1/8	6,600	1,000	2,000	300	Do.
Black Diamond No. 15	A	160	142	1	5,600	800	1,700	300	Do.
Black Diamond No. 55	A	208	109	1	9,200	1,400	2,800	400	Do.
Black Diamond A	A	194	117	1	7,200	1,100	2,200	300	Do.
Black Diamond G	B	90	252	1-1/8	6,900	1,000	2,100	300	Do.
Black Diamond Special A	A	169	134	1-1/4	3,900	600	1,200	200	Do.
Black Diamond Special C	A	138	164	1-1/4	4,900	700	1,500	200	Do.
Coalite B[2]	B	142	160	1	9,200	1,400	2,800	400	Atlas
Coalite C	A	168	135	1	10,200	1,500	3,100	500	Do.
Coalite C-1	A	166	137	1	9,800	1,500	3,000	500	Do.
Coalite G	A	152	149	1	6,600	1,000	2,000	300	Do.
Coalite G-1	A	153	148	1-1/8	6,200	900	1,900	300	Do.
Coalite K	B	101	225	1	7,900	1,200	2,400	400	Do.
Coalite K-1	B	101	225	1-1/8	7,900	1,200	2,400	400	Do.
Coalite LL	B	115	197	1-1/8	7,200	1,100	2,200	300	Do.
Coalite LL-1	B	115	197	1-1/8	7,200	1,100	2,200	300	Do.
Coalite LS	B	103	220	1	5,200	800	1,600	200	Do.
Coalite LS-1	B	103	220	1-1/8	5,600	800	1,700	300	Do.
Coalite M	B	124	183	1	7,900	1,200	2,400	400	Do.
Coalite M-1	A	123	185	1-1/4	7,900	1,200	2,400	400	Do.
Coalite MS	B	119	191	1-1/8	5,200	800	1,600	200	Do.
Coalite MS-1	A	119	191	1-1/8	5,600	800	1,700	300	Do.
Coalite S	B	138	164	1	6,600	1,000	2,000	300	Do.
Coalite S-1	A	138	164	1-1/4	6,600	1,000	2,000	300	Do.
Coalite T	A	139	163	1	4,900	700	1,500	200	Do.
Coalite T-1	A	134	169	1-1/8	4,900	700	1,500	200	Do.
Coalite 5-S	A	168	135	1-1/4	4,300	600	1,300	200	Do.
Coalite 7-R[3]	A	191	119	1	6,900	1,000	2,100	300	Do.
Coalite 7-S	A	189	120	1	8,500	1,300	2,600	400	Do.
Collier C[2]	A	149	152	1	10,200	1,500	3,100	500	Hercules
Duobel A	A	168	135	1	8,900	1,300	2,700	400	du Pont
Duobel B	A	150	151	1	8,200	1,200	2,500	400	Do.
Duobel C[2]	A	138	164	1	8,900	1,300	2,700	400	Do.
Duobel D	A	124	183	1	8,500	1,300	2,600	400	Do.
Duobel E	A	112	203	1	8,900	1,300	2,700	400	Do.
Duobel F	B	99	229	1	7,500	1,100	2,300	300	Do.
EL-446	A	188	121	1	7,900	1,200	2,400	400	Do.
EL-447	A	188	121	1	7,900	1,200	2,400	400	Do.
EL-454	A	190	119	1-1/4	6,900	1,000	2,100	300	Do.

See footnotes at end of table.

TABLE 1. - Nongelatinous permissible explosives (Con.)

Brand	Toxic gas classification	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Paper-tube rate in 1-1/4-inch diameter cartridge				Manufacturer[1]
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches					
Independent A	A	143	159	1-1/8	6,600	1,000	2,000	300	Independent
Independent B	B	98	232	1-1/4	5,600	800	1,700	300	Do.
Independent C	A	112	203	1-1/4	5,600	800	1,700	300	Do.
Independent C-1	A	122	186	1-1/8	5,600	800	1,700	300	Do.
Independent D	A	127	179	1-1/4	5,200	800	1,600	200	Do.
Independent E	A	179	127	1-1/4	6,200	900	1,900	300	Do.
Independent F	A	136	167	1-1/4	7,200	1,100	2,200	300	Do.
Independent G	B	100	227	1-1/4	6,600	1,000	2,000	300	Do.
Independent H	A	120	189	1-1/4	6,900	1,000	2,100	300	Do.
King No. 5-A[3]	A	163	139	1	7,900	1,200	2,400	400	King
King No. 7	A	183	124	1	8,900	1,300	2,700	400	Do.
King No. 7-A	B	155	146	1	9,500	1,400	2,900	400	Do.
King No. 7-AA	A	156	146	1	9,200	1,400	2,800	400	Do.
King No. 8[3]	A	134	169	1	6,200	900	1,900	300	Do.
King No. 9[3]	B	144	158	1	7,200	1,100	2,200	300	Do.
King No. 9-A[5]	A	147	154	1	6,600	1,000	2,000	300	Do.
King No. 11	B	123	185	1	7,200	1,100	2,200	300	Do.
King No. 11-A[3]	B	111	205	1	8,500	1,300	2,600	400	Do.
King No. 11-B[5]	A	115	197	1	5,900	900	1,800	300	Do.
King No. 12-B[5]	B	105	216	1-1/8	6,600	1,000	2,000	300	Do.
King No. 15	A	160	142	1	5,600	800	1,700	300	Do.
King No. 55[5]	A	208	109	1	9,200	1,400	2,800	400	Do.
King A	A	194	117	1	7,200	1,100	2,200	300	Do.
King G	B	90	252	1-1/8	6,900	1,000	2,100	300	Do.
King Special A[3]	A	169	134	1-1/4	3,900	600	1,200	200	Do.
King Special C[3]	A	138	164	1-1/4	4,900	700	1,500	200	Do.
Lump Coal C	A	137	166	1-1/4	4,900	700	1,500	200	du Pont
Lump Coal CC	A	136	167	1-1/8	5,900	900	1,800	300	Do.
Miners' Friend No. 2	B	166	137	1	8,500	1,300	2,600	400	Atlas
Monobel A	A	169	134	1	6,900	1,000	2,100	300	du Pont
Monobel AA[2]	A	190	119	1	8,900	1,300	2,700	400	Do.
Monobel B	A	150	151	1	7,200	1,100	2,200	300	Do.
Monobel C	A	137	166	1	6,900	1,000	2,100	300	Do.
Monobel D	B	123	185	1	6,600	1,000	2,000	300	Do.
Monobel E	B	111	205	1	6,900	1,000	2,100	300	Do.
National A	A	160	142	1	7,200	1,100	2,200	300	National
National A-1	A	183	124	1-1/8	8,900	1,300	2,700	400	Do.
National B	A	147	154	1	8,500	1,300	2,600	400	Do.
National C	B	100	227	1	7,200	1,100	2,200	300	Do.
National D	A	162	140	1	5,600	800	1,700	300	Do.
National E	A	143	159	1-1/8	6,600	1,000	2,000	300	Do.
National F	B	98	232	1-1/4	5,600	800	1,700	300	Do.
National F-1	B	90	252	1-1/8	6,900	1,000	2,100	300	Do.
National G	A	112	203	1-1/4	5,600	800	1,700	300	Do.
National H	A	127	179	1-1/4	5,200	800	1,600	300	Do.
Peerless No. 2[3]	A	164	138	1	6,900	1,000	2,100	300	Atlas
Red Crown B-3	A	155	146	1-1/4	6,900	1,000	2,100	300	King
Red Crown D-2[2]	A	139	163	1-1/4	5,200	800	1,600	200	Do.
Red HA	A	190	119	1	7,900	1,200	2,400	400	Hercules
Red HB[2]	A	162	140	1	10,200	1,500	3,100	500	Do.
Red HC[2]	A	163	139	1	5,600	800	1,700	300	Do.
Red HD	A	150	151	1	6,600	1,000	2,000	300	Do.
Red HF[2]	A	132	172	1	6,200	900	1,900	300	Do.
Red HL	A	119	191	1	6,900	1,000	2,100	300	Do.
Super-X No. 2[6]	A	134	169	1	9,500	1,400	2,900	400	Olin-Mathieson
Super-X No. 2-A[6]	A	142	160	1	6,200	900	1,900	300	Do.
Super-X No. 3[6]	A	150	151	1	6,600	1,000	2,000	300	Do.
Super-X No. 3-A[2,6]	A	181	125	1	8,500	1,300	2,600	400	Do.
Super-X No. 5[6]	A	186	122	1-1/4	8,200	1,200	2,500	400	Do.
Super-X No. 7[6]	A	177	128	1	6,600	1,000	2,000	300	Do.
Super-X No. 8[6]	A	129	176	1	6,200	900	1,900	300	Do.
Super-X No. 9[6]	A	114	199	1	4,600	700	1,400	200	Do.
Super-X No. 11[6]	B	86	264	1	5,900	900	1,800	300	Do.
Super-X Big Coal D[6]	A	162	140	1	4,900	700	1,500	200	Do.
Super-X Big Red No. 7-C[6]	A	160	142	1	7,900	1,200	2,400	400	Do.
Wesco Coal Powder No. 1	A	175	130	1-1/4	7,900	1,200	2,400	400	West

[1] For complete address and name of manufacturer, see appendix III.

[2] New basic data.

[3] Transferred from inactive list.

[4] Formerly listed as Austin Red Diamond No. 5, L. F.

[5] Same as other brand shown in Current Active List of Permissible Explosives.

[6] Formerly listed under other brand names as shown in Current Active List of Permissible Explosives.

TABLE 2. - Gelatinous permissible explosives

Brand	Toxic gas classification	Weight of 1-1/4- by 8-inch cartridges	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Paper-tube rate in 1-1/4-inch diameter cartridge				Manufacturer1/
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches					
Austin Red-D-Gel......	A	244	93	1	14,600	2,200	4,500	700	Austin
Black Diamond Nu-Gel No. 4...............	A	193	118	1	13,100	2,000	4,000	600	American
Gel-Coalite W.........	A	189	120	1	11,800	1,800	3,600	500	Atlas
Gel-Coalite X.........	A	239	95	1	7,200	1,100	2,200	300	Do.
Gel-Coalite Z.........	A	226	100	1	18,400	2,800	5,600	800	Do.
Gel-Coalite No. 3.....	A	183	124	1	10,500	1,600	3,200	500	Do.
Gelobel A.............	A	220	103	1	16,400	2,500	5,000	800	du Pont
Gelobel AA............	A	125	106	1	16,400	2,500	5,000	800	Do.
Gelobel C.............	A	190	119	1	12,100	1,800	3,700	600	Do.
Hercogel 22/..........	A	190	119	1	10,800	1,600	3,300	500	Hercules
Hercogel A............	A	220	103	1	17,100	2,600	5,200	800	Do.
Independent Gel-A.....	A	244	93	1	14,800	2,200	4,500	700	Independent
King Nu-Gel No. 43/....	A	193	118	1	13,100	2,000	4,000	600	King
Napcogel No. 1........	A	216	105	1-1/8	14,100	2,100	4,300	600	National
Permigel A............	A	218	104	1	17,100	2,600	5,200	800	American
Permigel B............	A	189	120	1	10,500	1,600	3,200	500	Do.
Super-X Gel4/.........	A	226	100	1	13,500	2,000	4,100	600	Olin-Mathieson
Super-X Gel A4/.......	A	227	100	1	15,100	2,300	4,600	700	Do.
Super-X Gel B4/.......	A	171	133	1	10,800	1,600	3,300	500	Do.

1/ For complete name and address of manufacturer, see appendix III.
2/ New basic data.
3/ Transferred from inactive list.
4/ Formerly listed under other brand name as shown in Current Active List of Permissible Explosives.

TABLE 3. - Permissible Cardox models manufactured by Cardox Corp., Chicago, Ill.

Number of:		Dimension of shell				Authorized combinations			
		Length		Diameter		Shear opening in discharge cap, diameter	Heater, maximum weight of ingredient (potassium perchlorate-coal mixture)	Disk (sheet metal)	
Approval	Extension	Cm.	In.	Cm.	In.	In.	Grams	Minimum gage	Minimum shearing pressure per sq. in., thousands of pounds[1]
CARDOX MODEL B-20									
Usual charge of carbon dioxide 255 grams[2]									
7 and 18	1 and 2	60.7	23-7/8	4.4	1-3/4	7/8	35	12	18
						7/8	45	10	23
CARDOX MODEL B-37									
Usual charge of carbon dioxide 450 grams[2]									
6 and 18	2 and 3	103.2	40-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23
CARDOX MODEL B-44									
Usual charge of carbon dioxide 570 grams[2]									
8 and 18	2 and 3	118.4	46-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23
CARDOX MODEL D-100									
Usual charge of carbon dioxide 1,425 grams[2]									
5 and 18	3 and 4	118.1	46-1/2	6.4	2-1/2	1-7/16	180	[3] 10	17
CARDOX MODEL 2-50									
Usual charge of carbon dioxide 675 grams[2]									
18		88	34-5/8	5.1	2	1-1/16	80	12	13
						1-1/16	100	10	17
CARDOX MODEL 2-80									
Usual charge of carbon dioxide 1,075 grams[2]									
18		118.4	46-5/8	5.1	2	1-1/16	100	12	13
						1-1/16	110	10	17
CARDOX MODEL 2-100									
Usual charge of carbon dioxide 1,425 grams[2]									
18		148.9	58-5/8	5.1	2	1-1/16	110	12	13
							110	10	17
CARDOX MODEL 231-130									
Usual charge of carbon dioxide 1,800 grams[2]									
18		151.4	59-5/8	5.9	2-5/16	1-3/8	130	[3] 12	12
						1-3/8	160	[3] 10	16
CARDOX MODEL 3-200									
Usual charge of carbon dioxide 2,800 grams[2]									
18		134.0	52-3/4	7.6	3	1-3/4	200	[3] 12	10
						1-3/4	200	[3] 10	13

[1] Minimum shearing pressures allow a reasonable tolerance from those actually determined by tests.

[2] Maximum weight of heater and minimum disk gage are combinations for the usual charge of carbon dioxide as stated for each model. Combinations studied and tested at the gallery were with low charges of carbon dioxide. Therefore, a charge of carbon dioxide less than that usually used does not affect the permissible use of the device.

[3] Strip-steel disks instead of sheet metal.

TABLE 4. - Permissible Hydrox models manufactured by Hercules Powder Co., Wilmington, Del.

Model	Approval number	Shell					Cartridge				
		Length		Diameter		Weight	Length		Diameter		Weight
		Cm.	In.	Cm.	In.	lb.	Cm.	In.	Cm.	In.	grams
LP - 2-1/2......	26-25	167.6	66	6.7	2-5/8	52	48	18.9	4.8	1-7/8	558.6
B - 37.........	26-26	169.2	66-5/8	4.4	1-3/4	25	59	23.2	3.2	1-3/16	250.5

APPENDIX I. - GENERAL REQUIREMENTS FOR PERMISSIBLE EXPLOSIVES

Explosives enumerated on the permissible lists of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

(1) The explosive must conform, within limits of tolerances prescribed by the Bureau of Mines, with the basic sample, and the diameters of the cartridges used must be those that have been approved.

(2) Electric detonators (not fuse and detonators) must not be less efficient than a No. 6, the detonating charge of which shall consist of a 1-gram mixture of 80 parts of mercury fulminate and 20 parts of potassium chlorate (or their equivalents).

(3) The explosive must be stored in surface magazines under proper conditions so that it does not undergo change in character, and after taking it underground it must be used in less than 48 hours.

(4) The explosive must be used in conformance with all the applicable provisions specified in the current edition of the Federal Mine Safety Code.

APPENDIX II. - GENERAL REQUIREMENTS FOR PERMISSIBLE BLASTING DEVICES

Blasting devices enumerated in the permissible lists of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

(1) The blasting device must conform to the specifications for the model as originally approved.

(2) The blasting device must not be discharged in the presence of firedamp that can be detected with a permissible flame safety lamp.

(3) The electrical unit used to fire the blasting device must be suitable for the purpose and meet the Bureau of Mines' requirements applicable to that particular type of unit. The unit must also be used in a manner prescribed by the Bureau.

(4) The blasting device must not be fired until everyone is a safe distance from the shot and protected by adequate cover, having 1 or, if possible, 2 right angles between them and the blast.

(5) The coal to be blasted must be undercut or equivalently relieved; the length of shot holes must be at least 6 inches less than the depth of the undercut or equivalent relief; and the shot shall be at least 6 inches away from the face of an undercut, or equivalent relief.

(6) No blasting device shall be assembled or disassembled in a mine unless such permission is stated in the approval.

(7) A misfired blasting device may not be opened in the mine unless an exception to this section is included as part of the approval for each specific blasting device. The conditions that constitute a misfire will be specified in the approval.

(8) A waiting period of 15 minutes shall be required before any personnel is allowed to return to the face after a misfire has occurred.

(9) The blasting device must be used in conformance with all applicable provisions specified in the current edition of the Federal Mine Safety Code.

(10) Other conditions, which will be set down by the Bureau as appropriate to the particular blasting device tested, must be observed.

APPENDIX III. - NAMES AND ADDRESSES OF MANUFACTURERS LISTED

American: American Cyanamid Co., New York, N. Y.
Apache: Apache Powder Co., Benson, Ariz.
Atlas: Atlas Powder Co., Wilmington, Del.
Austin: Austin Powder Co., Cleveland, Ohio.
Cardox: Cardox Corp., Chicago, Ill.
du Pont: E. I. du Pont de Nemours & Co., Wilmington, Del.
Hercules: Hercules Powder Co., Wilmington, Del.
Independent: Independent Explosives Co., Scranton, Pa.
King: King Powder Co., Inc., Cincinnati, Ohio.
National: National Powder Co., Eldred, Pa.
Olin: Olin-Mathieson Chemical Corp., East Alton, Ill.
West: West Coast Powder Co., Everett, Wash.

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